Chemistry 12

August 2003 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

Organizers	Sub-Organizers
1. Reaction Kinetics	A, B, C
2. Dynamic Equilibrium	D, E, F
3. Solubility Equilibria	G, H, I
4. Acids, Bases, and Salts	J, K, L, M, N, O, P, Q, R
5. Oxidation – Reduction	S, T, U, V, W

Part A: Multiple Choice

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	A	K	1	1	A1	25.	D	U	2	4	J11
2.	D	U	1	1	A4	26.	D	U	1	4	K6
3.	C	K	1	1	B1, 3	27.	C	K	1	4	L2
4.	A	H	2	1	B6, 7	28.	D	U	2	4	L12
5.	C	U	2	1	B9	29.	A	U	1	4	M2
6.	C	U	1	1	C1	30.	B	K	1	4	N1
7.	A	U	1	2	D3	31.	C	U	2	4	M2, N3
8.	C	K	2	2	E1	32.	D	H	2	4	O3
9.	C	U	1	2	E2, 4	33.	B	U	1	4	O5
10.	A	H	1	2	E2	34.	D	K	1	4	P1
11.	A	H	1	2	F1	35.	B	U	2	4	P3
12.	A	K	1	2	F3	36.	C	U	1	4	Q2
13.	D	U	1	2	F4	37.	D	K	1	4	R1
14.	D	U	2	2	F8	38.	A	U	1	5	S1
15.	D	K	1	3	G1	39.	D	K	1	5	S1
16.	A	K	1	3	G3, 6	40.	B	H	1	5	S2
17.	C	U	1	3	G8	41.	B	U	2	5	S4
18.	D	H	1	3	H2	42.	C	U	1	5	S6
19.	B	U	1	3	H3	43.	B	U	1	5	U2
20.	B	U	1	3	H5	44.	D	U	1	5	U5
21.	A	U	1	3	I3	45.	C	U	1	5	U3, 4
22.	C	U	2	3	H1, I5	46.	B	U	1	5	U2
23.	A	K	1	4	J2	47.	B	U	1	5	U9
24.	B	H	2	4	H2, J3	48.	C	U	1	5	W4

Multiple Choice = 60 marks (48 questions)

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	3	1	B9
2.	2	U	2	1	C4
3.	3	H	3	2	E3
4.	4	U	3	2	F8
5.	5	U	6	3	I6
6.	6	U	2	4	J3
7.	7	U	2	4	K10
8.	8	U	2	4	L7
9.	9	U	5	4	M3
10.	10	U	3	4	Q3
11.	11	U	3	5	S6, T2
12.	12	H	1	5	S6, W5
13.	13	U	5	5	W2, 3, 4

Written Response = 40 marks

Multiple Choice = 60 (48 questions)
Written Response = 40 (13 questions)
EXAMINATION TOTAL = 100 marks

LEGEND:
Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **CO** = Curriculum Organizer
PLO = Prescribed Learning Outcome

PART B: WRITTEN RESPONSE

Value: 40 marks **Suggested Time: 50 minutes**

INSTRUCTIONS:	You are expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in the spaces below the questions. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculations, full marks will NOT be given for providing only an answer.**

1. Consider the following reaction: **(3 marks)**

$$Mg_{(s)} + 2HBr_{(aq)} \rightarrow MgBr_{2(aq)} + H_{2(g)} + \text{energy}$$

In terms of collision theory, describe how each of the factors below would influence the reaction rate.

a) Increasing the concentration of HBr: _____

_____

Solution:

For Example:

Greater concentration and more collisions. Therefore more successful collisions and a greater rate. } ← **1 mark**

b) Decreasing the temperature: _____

_____

Solution:

For Example:

Fewer collisions with sufficient energy to overcome PE barrier. Therefore, a lower rate. } ← **1 mark**

c) Increasing the surface area of Mg: _____

_____

Solution:

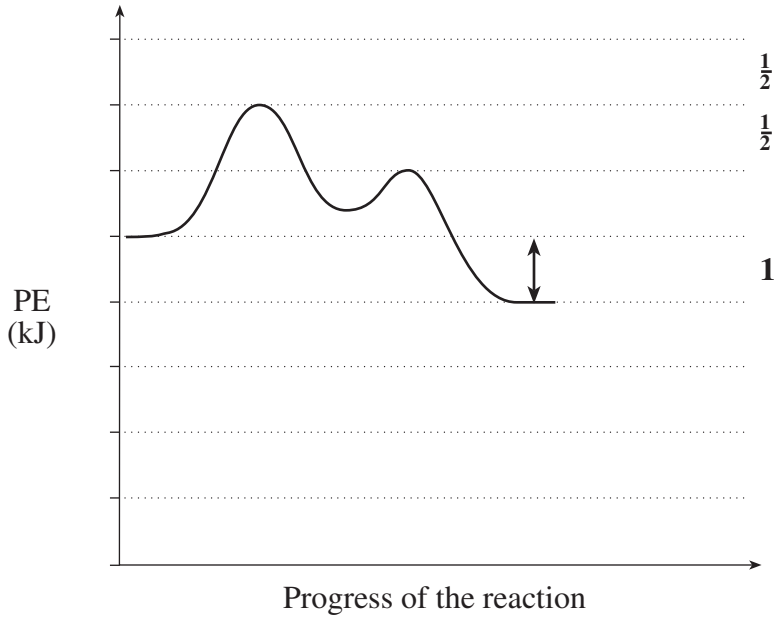
For Example:

Increased surface area leads to more collisions and more successful collisions. Therefore, a higher rate. } ← **1 mark**

2. Consider the following reaction mechanism: **(2 marks)**

Step 1	$NO_{(g)} + O_{2(g)} \rightarrow NO_{3(g)}$ slow
Step 2	$NO_{3(g)} + NO_{(g)} \rightarrow 2NO_{2(g)}$

The overall reaction is exothermic. Sketch a PE diagram on the axes below to describe the energy changes that occur as the reaction takes place.



½ mark for 2 humps

½ mark for first hump higher than second

1 mark for exothermic reaction

Solution:

For Example:

See diagram above.

3. Consider the following equilibrium system: **(3 marks)**

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$$

The system is said to "shift right" as the result of the addition of **extra** $H_{2(g)}$. Describe the sequence of changes in both forward and reverse reaction rates as the system goes from the original equilibrium to the new equilibrium.

Solution:

For Example:

As $[H_2]$ is increased the forward rate increases. The forward rate will be greater than the reverse rate, resulting in more HI being produced. ← **1 mark**

The $[H_2]$ is consumed as the shift occurs and the forward rate starts to decrease. The increasing $[HI]$ results in an increasing reverse rate. ← **1 mark**

At the new equilibrium the forward and reverse rates will be equal. ← **1 mark**

4. Consider the following equilibrium system: **(3 marks)**

$$2NO_{(g)} + Cl_{2(g)} \rightleftarrows 2NOCl_{(g)} \qquad K_{eq} = 8.5$$

A closed flask is found to contain $0.40\,M\ NO_{(g)}$, $0.32\,M\ Cl_{2(g)}$ and $5.6\,M\ NOCl_{(g)}$. Use appropriate calculations to determine the direction the reaction proceeds to reach equilibrium.

Solution:

For Example:

$$\text{Trial } K_{eq} = \frac{[NOCl]^2}{[NO]^2[Cl_2]} = \frac{(5.6)^2}{(0.40)^2(0.32)} = 6.1 \times 10^2$$ } ← **1 mark**

Since Trial $K_{eq} > K_{eq}$, ← **1 mark**

the equilibrium will proceed left to reduce the Trial K_{eq} value to K_{eq}. ← **1 mark**

5. Calculate the maximum mass of $BaCl_{2(s)}$ that can be added to 250 mL of 0.50 M $Pb(NO_3)_{2(aq)}$ without forming a precipitate of $PbCl_{2(s)}$. **(6 marks)**

Solution:

For Example:

$$PbCl_{2(s)} \rightleftarrows Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

$$K_{sp} = [Pb^{2+}][Cl^-]^2$$

$$1.2 \times 10^{-5} = (0.50)[Cl^-]^2$$

$$[Cl^-] = 4.90 \times 10^{-3}\ M$$

← **3 marks**

In 250 mL:

moles $Cl^- = 4.90 \times 10^{-3}$ mol/L $\times$ 0.25 L $= 1.22 \times 10^{-3}$ mol Cl^- ← **1 mark**

moles $BaCl_2 = \frac{1}{2}$ mol Cl^-

$= \frac{1}{2} \times 1.22 \times 10^{-3}$ mol

$= 6.12 \times 10^{-4}$ mol ← **1 mark**

$$\text{Mass } BaCl_2 = 6.12 \times 10^{-4}\ \text{mol} \times \frac{208.3\ \text{g}}{1\ \text{mol}}$$

$= 0.13$ g $BaCl_2$ ← **1 mark**

(Deduct **$\frac{1}{2}$ mark** for incorrect significant figures.)

6. Write the net ionic equation for the acid-base reaction that occurs between $NaCN_{(aq)}$ and $NH_4Cl_{(aq)}$. **(2 marks)**

Solution:

For Example:

$$CN^-_{(aq)} + NH_4{}^+_{(aq)} \rightleftarrows HCN_{(aq)} + NH_{3(aq)}$$ ← **2 marks**

7. Define the term *amphiprotic* and give an example of an amphiprotic anion. **(2 marks)**

Solution:

For Example:

Definition: Amphiprotic describes a substance that can act as either an acid or a base.

Example: HCO_3^-

← **2 marks**

8. At $20°C$, the ionization constant of water (K_w) is 6.76×10^{-15}.
Calculate the $[H_3O^+]$ of water at $20°C$. **(2 marks)**

Solution:

For Example:

$$K_w = [H_3O^+][OH^-] = 6.76 \times 10^{-15} \quad \leftarrow \textbf{1 mark}$$

Since $[H_3O^+] = [OH^-]$, $[H_3O^+]^2 = 6.76 \times 10^{-15}$

$$[H_3O^+] = 8.22 \times 10^{-8}\ M \quad \leftarrow \textbf{1 mark}$$

9. Calculate the pH of 0.50 M NaF. **(5 marks)**

Solution:

For Example:

	F^-	+	H_2O	$\rightleftarrows$	HF	+	OH^-
[I]	0.50				0		0
[C]	$-x$				$+x$		$+x$
[E]	$0.50 - x$				x		x

} ← **1 mark**

(assume x is negligible)

$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{3.5 \times 10^{-4}} = 2.86 \times 10^{-11} = \frac{[HF][OH^-]}{[F^-]}$$

} ← **1 mark**

$$2.86 \times 10^{-11} = \frac{x^2}{0.50}$$ ← **1 mark**

$$x = [OH^-] = 3.78 \times 10^{-6}\ M$$ ← **1 mark**

$$pOH = 5.42$$
$$pH = 8.58$$

} ← **1 mark**

(Deduct **$\frac{1}{2}$ mark** for incorrect significant figures.)

10. Outline a procedure to prepare a buffer solution. **(3 marks)**

Solution:

For Example:

Prepare an aqueous mixture that contains:

1. a weak acid
2. a salt of its conjugate base
3. the acid and salt in sufficient concentrations

← **3 marks**

11. A reaction occurs when copper metal is dropped into a solution of silver nitrate. Write the balanced formula equation and the balanced net ionic equation for this reaction. **(3 marks)**

Solution:

For Example:

Formula equation:

$$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

Net ionic equation:

$$Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$$

← **3 marks**

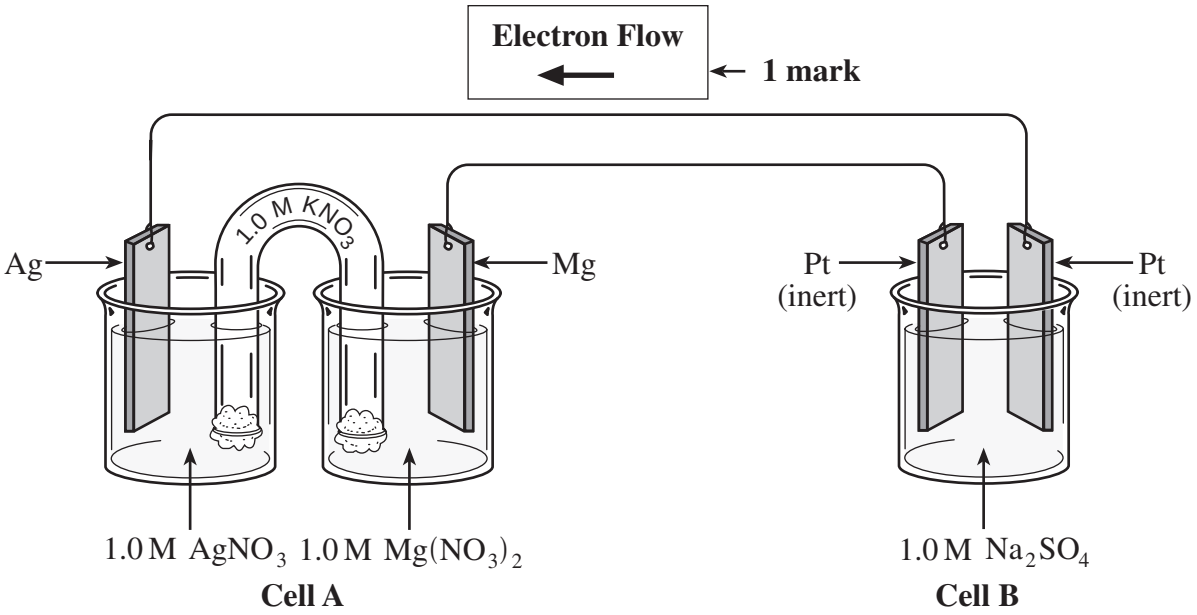
12. When setting up the apparatus to electroplate a zinc object with copper, the object is suspended in a Cu^{2+} solution. Explain why it is a good idea to turn on the power supply before immersing the electrodes in the solution. **(1 mark)**

Solution:

For Example:

If you did not turn on the power supply before immersing the electrodes in the solution, the Cu^{2+} would react spontaneously with the zinc to be plated, oxidizing the zinc. ← **1 mark**

13. Consider the following apparatus consisting of an electrochemical cell joined to an electrolytic cell:



a) On the diagram above, indicate the direction of electron flow in the top wire. **(1 mark)**

Solution:

For Example:

See diagram above. ← **1 mark**

b) Which metal in cell A is the cathode? **(1 mark)**

Solution:

Cathode: Ag ← **1 mark**

c) Write the anode and cathode half-reactions for cell B. **(3 marks)**

Solution:

For Example:

Anode: $H_2O \rightarrow 2H^+ + \frac{1}{2}O_2 + 2e^-$

Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

← **3 marks**

END OF KEY